

In the above statements the octave  $c-c'$  is for simplicity supposed to be true. The actual error could be readily allowed for, if required; but in practice it is not necessary to use  $c'$  at all, inasmuch as the third set of beats can be counted equally well between  $g\#$  and  $c$ .

Although at first sight the method just sketched looks satisfactory, it is not practical in the case of the harmonium, in consequence of the pitch of the various notes not being sufficiently constant for the purpose, even when the blowing is carefully conducted with the aid of a pressure-gauge. A small variation in the absolute pitch of a chord when sounded under slightly varying pressures, would not be of much importance, but the slightest change of interval is fatal to the success of the method, and such a change actually occurs.

In order, therefore, to apply the fundamental principle with success, it is necessary to be able to check the accuracy of the interval which is supposed to be known, at the same time that the beats are being counted. If the interval be a major tone ( $9:8$ ), its exactness is proved by the absence of beats between the ninth component of the lower, and the eighth component of the higher note, and a counting of the beats between the tenth component of the lower and the ninth of the higher note completes the necessary data for determining the absolute pitch.

The equal temperament whole tone ( $1'12246$ ) is intermediate between the minor tone ( $1'11111$ ) and the major tone ( $1'12500$ ), but lies much nearer to the latter. Regarded as a disturbed major tone, it gives slow beats, and regarded as a disturbed minor tone it gives comparatively quick ones. Both sets of beats can be heard at the same time, and when counted give the means of calculating the absolute pitch of both notes. If  $x$  and  $y$  be the frequencies of the two notes,  $a$  and  $b$  the frequencies of the slow and quick beats respectively,

$$\begin{aligned} 9x - 8y &= a \\ 9y - 10x &= b, \end{aligned}$$

whence

$$\begin{aligned} x &= 9a + 8b \\ y &= 10a + 9b. \end{aligned}$$

The application of this method in no way assumes the truth of the equal temperament whole tone, and in fact it is advantageous to flatten the interval somewhat by loading the upper reed with a minute fragment of soft wax, so as to make it lie more nearly midway between the major and the minor tone. In this way the rapidity of the quicker beats is diminished, which facilitates the counting.

It is impossible, of course, for the same observer to count both sets of beats, and the counting of even one set without the aid of resonators would present difficulties to most unpractised persons. Great assistance may be obtained by the choice of a suitable position. A room in which a pure tone is sounded is traversed by surfaces at which the intensity of sound is very much reduced in consequence of the superposition of vibrations reflected from the walls and ceiling. By choosing as the place of observation a position where the intensity of the beats which are not to be counted is a minimum, and with the aid of a resonator tuned to the pitch of the beats which are to be counted, the listener is able to work with ease and certainty.

The course of an experiment is then as follows:—The notes  $C$  and  $D$  are sounded, and the listeners begin counting the beats at a given signal, whose pitch is about  $d''$  and  $e''$  respectively. At the expiration of a measured interval of time a second signal is given, and the number of both sets of beats is recorded.

In my experiments the interval of time was ten minutes (in one case eleven minutes), and the rapidity of the beats was about four a second. The listeners counted up to ten only, after each set of ten making a stroke with a pencil on a piece of paper. The number of strokes was

afterwards counted, multiplied by ten, and added to the number which the listener was saying at the instant of the second signal. The following are the details of the actual observations:—

September 16, 1878.—Period of observation ten minutes. Numbers of beats 2392 and 2341.

$$a = \frac{2392}{600}, b = \frac{2341}{600}, \text{ giving } x = \frac{9 \times 2392 + 8 \times 2341}{600} = 67.09,$$

for the frequency of the lower note C.

September 17.—Period of observation ten minutes.

$$a = \frac{2423}{600}, b = \frac{2302}{600}, \text{ giving } x = 67.04.$$

September 18.—Period of observation ten minutes.

$$a = \frac{2476}{600}, b = \frac{2261}{600}, \text{ giving } x = 67.29.$$

September 19.—Period of observation eleven minutes.

$$a = \frac{2663}{600}, b = \frac{2547}{600}, \text{ giving } x = 67.19.$$

The discrepancies are hardly greater than may be attributed to errors in giving the signals, by which the intervals may have been unduly lengthened or shortened by about a second. On each day after the counting of the beats between C and D, the harmonium was compared with a Koenig fork whose nominal frequency was 64. In order to obviate any objection arising from a mutual influence of the notes of the harmonium, both C and D were sounded at the same time as the fork. The beats between C and the fork were counted for about ninety seconds, during which time the fork was not bowed. In this way the pitch of the fork came out on the four days respectively as 64.06, 64.07, 64.17, 63.98, that is somewhat sharper than its nominal pitch, a result in agreement with that obtained by other methods.

The object of the experiments referred to was rather to prove the practicability of a method so unusually independent of special apparatus, than to obtain a result competing in point of accuracy with those of Prof. Macleod and other experimenters on this subject. Nevertheless it is believed that very accurate results might be obtained by the introduction of certain modifications. Ten minutes is near the limit of time over which beats can be conveniently counted by a single listener, but experiment proved that it is perfectly possible for one listener to relieve another without any break in the regularity of the counting. Even without an extension of time a more accurate result would be obtained if the listeners were able to fix the time for themselves, as they might do for example if they could conveniently observe the swinging of a clock pendulum. In this way the error in the time interval might be reduced to  $\frac{1}{4}$  second, which would amount to but one part in 2400 in the case of a ten minutes' observation. In consequence, however, of the imperfect constancy of the pitch of the harmonium notes, even when the blower is assisted by a pressure-gauge, further attempts at accuracy would be useless unless the comparison with the fork were simultaneous with the other observations. In that case the result would be entirely independent of variations in the harmonium notes, and no difficulty would be experienced in carrying out the method excepting the necessity for more observers.

#### THE FISSURES OF THE CEREBRAL HEMISPHERES IN UNGULATA

A N important memoir by Dr. Krueg on the cerebral hemispheres of Ungulata has recently appeared in the *Zeitsch. wiss. Zool.* After a review of the previous papers that have appeared on this subject—but few in number—Dr. Krueg describes his method of investigation.

He made drawings of the hemisphere of each species; compared, first, line for line the hemispheres of different individuals of the *same* species, and then took as characteristic of that species every sulcus that was constantly present in all the individual hemispheres.

The different species in a genus and the different genera in the order were compared in the same way, so that by elimination he at last obtained a schematic drawing of the sulci constant throughout the order. In his drawings he represents those sulci peculiar to the individual, species, &c., by variously dotted lines, those running through the whole order by thick black lines.

Since the most constant or chief sulci are the first to appear in the course of development, he gives drawings of foetal brains of the sheep, cow, and pig. With regard to these foetal brains, it is highly important to note that in no instance were transitory or temporary sulcus markings met with; Meckel himself admits that he did not find these temporary sulci in brains of other animals, though he described them in the human fetus. Dr. Krueg regards them as entirely artificial. The following, then, are the chief fissures or sulci (*Hauptfurchen*) constant throughout the Ungulata, and of these the first six are the most important in relation to those of the Carnivora:—

- |             |                                                   |
|-------------|---------------------------------------------------|
| 1.          | <i>Fissura sylvii</i> , ant., post., processus ad |
| 2.          | " <i>splenialis</i> .                             |
| 3.          | " <i>supra-sylvia</i> , ant., post., supr.        |
| 4.          | " <i>coronalis</i> .                              |
| 5.          | " <i>præsylvia</i> .                              |
| 6.          | " <i>lateralis</i> .                              |
| 7.          | " <i>diagonalis</i> .                             |
| 8.          | " <i>postica</i> .                                |
| 9.          | " <i>genualis</i> .                               |
| 10.         | " <i>rostralis</i> .                              |
| h.          | " <i>hippocampi</i> .                             |
| rh.         | " <i>rhinalis</i> .                               |
| <i>Cca.</i> | <i>Corpus callosum</i> .                          |

The earliest foetus he possesses shows two fissures, namely, *F. sylvii* and *F. splenialis*. The sylvian fissure develops radially, just as Ecker has shown in the human foetus, and since in the latter, the parieto-occipital fissure appears almost contemporaneously with the sylvian fissure, he considers the *Fissura splenialis* of Ungulates to be the homologue of the human parieto-occipital. This view derives some strength from the fact that as development proceeds, the anterior extremity of the *Fissura splenialis* turns upwards and gains the median border. Moreover, here it is opposite to the *processus acuminis Sylvii*, which is homologous with the posterior or horizontal ramus of the human *Sylvian fissure*.

The positions of the fissures are shown in the accompanying diagrams. As regards the foetal forms it is noteworthy that in the Suillidæ, from its earliest appearance the posterior process of the F. supra-Sylvia is directed downwards as well as backwards; this we shall find is a family characteristic of importance.

Before enumerating the slighter distinctive characters of the families, or comparing the Ungulata with the Carnivora, it will be well to mention the results which are of more general importance. Dr. Krueg believes that he has established the following propositions:—

- That the forerunners of the adult fissures are never transitory radial markings, but always present (though incompletely) the adult form.
  - That the two important fissures (*F. hippocampi* and *F. rhinalis*) common to all mammals, are the first to appear, and that next those characteristic of the Ungulata commence.

It is remarkable that the fissures peculiar to the indi-

It is remarkable that the fissures peculiar to the individual, may appear contemporaneously with, or even precede, the last few of the chief fissures. This fact of itself would cast some doubt on the morphological value of these later chief fissures, and comparison with the Carnivora also diminishes their importance as diagnostic marks.

3. On no occasion was a fissure once formed ever broken up by a bridging convolution. The reverse of this may and often does occur, viz., that two originally distinct fissures may, by extension of their neighbouring extremities, so mingle as to form one large fissure. From this fact he concludes that when in adult brains we meet with a well-known fissure bridged over, originally this fissure was developed as two distinct ones. This would certainly explain the remarkable cases lately published by

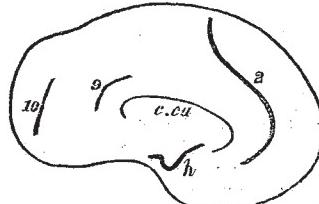


FIG. 1.—Median surface of typical hemisphere.

Henschel, in which the fissure of Rolando was bridged over, and such a state of things would be due to atavism.

4. The influence of the size of the animal on the shape of the hemisphere and its details is very important, and may be regarded as threefold.

- (a) The number of accessory fissures increases with the size of the brain and the size of the animal.

(b) The shape of the hemisphere differs. Thus, in the larger animals it is broader, and more rounded, whereas, in the smaller animals it is distinctly narrower, and tapers more to a point anteriorly.

(c) In the smaller animals it is noticed at once that fissures (such as the splenialis), which in the schematic brain are situated on the median surface, in these smaller individuals, often appear on the upper. Such a condition may be supposed to result from a rotation of the upper or median border around the Island of Reil as a centre. This rotation Dr. Krueg has named "supination," and that in the opposite direction and occurring in the larger animals "pronation." The posterior extremity of the F. coronalis almost always presents a "horn" (Bügel) directed inwards. This branch becomes of importance, as it often joins the F. splenialis, and offers a homology with the fissura cruciata of the Carnivora.

The following are the main family characteristics :—

*Tragulidae*.—Supination marked. F. coronalis communicates with the processus anterior supra-Sylvii. The *Tragulidae* (like the antelopes) present strong elephantine characters as regards their fissures.

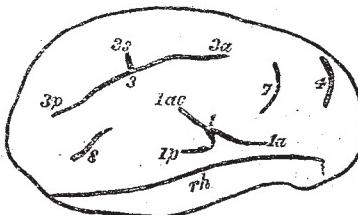


FIG. 2.

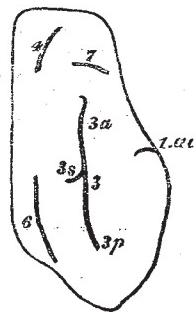


FIG. 3.

FIG. 2.—Lateral outer surface of typical hemisphere. FIG. 3.—Upper surface of typical hemisphere.

*Elephants*.—*F. coronalis* communicates with the processus anterior supra-Sylvii, and also either with the *F. splenialis* or ends just behind it.

The *Giraffes* present no generic characters.

*Cavicornis*.—In the majority the *F. coronalis* does not communicate with the *F. supra sylvii*, the exception being *Bos taurus*. The processus acuminis *Sylvii* is broken

by "individual" fissures, and, moreover, the angle formed between its anterior and posterior extremities is raised, and into this space a small accessory branch from the Fissura rhinalis is directed.

*Tylopoda*.—Pronation is so marked that the F. lateralis is actually situated on the median surface. The F. coronalis is directed from the middle line forwards and outwards.

*Suillidae* present several characters in common with the Carnivora. The processus anterior Sylvii is continued into the F. rhinalis, as is also the F. præsylvia.

The F. diagonalis is constantly joined to the F. supra Sylvia, and the posterior end of the F. coronalis joins the F. splenialis.

*Hippopotamidae*.—Like the pig.

*Tapiroidea*.—Posteriorly the F. coronalis does not join any other fissure, but anteriorly it communicates with the F. præsylvia, a fact which, though frequent in Perissodactyls, is rare in Artiodactyls.

*Nasicornidae* are similar to the Solidungulates.

*Solidungulata*.—The peculiarities are very constant. Thus there are cross-fissures between F. Sylvii and F. supra Sylvii. Further, there is an accessory longitudinal and parallel fissure on either side of the F. lateralis. Pronation is marked. The F. coronalis is united to the F. supra Sylvii, and the posterior "horn" of the F. coronalis is not united to that fissure, but commencing behind and above the anterior end of F. splenialis, runs forwards and outwards, ending before reaching F. coronalis.

Comparison of the convolutions of the Ungulata with those of the Carnivora shows that in the latter order the first six chief sulci of the Ungulata have undoubtedly their homologues. The question as to whether a F. diagonalis can be said to exist must still be left open, and the remaining three certainly do not always exist in the brain of the Carnivora, and when present are accessory only.

Dr. Krueg thinks that possibly the posterior "horn" (Bügel) of the Fissura coronalis is homologous with the Fissura cruciata in the Carnivora, but this is very uncertain, for it is questionable whether in the Caviornia the posterior limb of the F. coronalis is homologous with the distinct one described above in the Equidae. Certainly that of the Perissodactyl is very similar to the Fissura cruciata as regards its relation to the F. coronalis; but while in the Perissodactyl the posterior extremity begins above the F. splenialis, in all Carnivora it begins below. Further, the anterior end of the F. splenialis turning up to the median border has a plausible homology itself with the Fissura cruciata. It would be very interesting to have the time of appearance of the Fissura cruciata fixed, for the latter theory would compare it to the human parieto-occipital fissure. As confirmatory evidence regarding the homology of the Ungulate and Carnivore Fissuræ coronales, we must note the important fact that similar cortical motor centres are situate around them: this is strongly in favour of Dr. Krueg's view.

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#### NOTES

PROF. W. K. CLIFFORD has arrived safely at Madeira. The voyage was rough and stormy, but we are glad to be able to report that he is markedly better than when he left England.

A SUBSCRIPTION has been opened by the Dorpat University for the erection at Dorpat of a monument to the late K. von Baer.

ON January 10 the Imperial Russian Academy of Sciences at St. Petersburg held its annual meeting, which was largely attended this year. The meeting was opened with the reading of the long list of deaths of members, foreign and Russian, during last year, and among whom we notice Regnault, Claude Bernard, Granville, and Bienaimé, at Paris; Hugo Hildebrandt, of

Jena; Friis, of Upsala; Tornberg, of Lund; Lers, of Königsberg; and the well-known Russian archaeologist Polyenoff; Kovalsky and Khanykoff, orientalists; and Davydoff, mathematician. Count Orloff-Davydoff, Baron Bühler, and Col. Prjvalsky were elected honorary members; and General Maiefsky, mathematician; General Stebnitzky, geodesist at Tiflis; Mr. Hind (as noted last week), Dr. John Muir (Edinburgh), Clausius (Bonn), Boisier (Geneva), Lavrofsky and Veselago were elected correspondent members of the Academy. The report on the museums of the Academy showed several most important acquisitions, among which we notice the immense and very rich collections of birds, fishes, and reptiles brought in from Central Asia by Col. Prjvalsky, during his second journey; a collection of skulls and bones of Steller's sea-cow, which inhabited, during the last century, the shores of the White Sea, but is now extinct, the collection being made by M. Phillipens on the shores of Behring Strait; and a complete skull of an Elasmotherium, presented by M. Knoblauch. There were, until now, only some teeth of this immense quaternary horse-like rhinoceros at the museum of the Academy, and a part of a skull at the British Museum, which had offered, we are told, a large sum of money to M. Knoblauch for the rarity. The skull was found close by Sarepta, on the banks of the Volga River. The Academy proposes to open next year for the public a large anthropological museum, the materials for which are already in the hands of the Academy; we heartily commend this step, as the museums of the Academy, when open to the public each Monday, are visited by masses of people (as many as 12,000 persons daily on holidays). The report on the works of the philological and historical branch of the Academy was presented by Prof. Suklomlinoff, who dwelt at length on the works of Prince Vyazemsky; and a very interesting paper on the correspondence between Catherine II. and Grimm was read by Prof. Groth. In this branch we notice a great undertaking by the Academy for the next year, being a dictionary of the Kurd language. This language has been very well studied, but there are no dictionaries of it. Now, the Academy will publish a complete one, the materials for it being given by the French orientalist, M. Szabo, and completed by M. Yulpi, who will be intrusted with this important publication.

WE notice an interesting work, just issued in Russia, by Prof. Rumishevich at Kieff, being a complete catalogue of all the medicinal and veterinary literature published in Russia during 1876.

WE learn that the St. Petersburg Academy of Sciences has intrusted M. Keppen with the publication of a complete catalogue of animals living in European Russia.

LORD DUFFERIN, Lord Rosse, and Prof. Roscoe received the degree of LL.D. from Trinity College, Dublin, on Tuesday.

THE "Telectroscope" is the name of a new apparatus, the plan of which was, *Les Mondes* states, recently submitted to MM. du Moncel and Hallez d'Arros by M. Senlecq, intended to reproduce telegraphically at a distance the images obtained in the camera obscura. This apparatus is based on the well-known sensitiveness of selenium to various shades of light.

PROF. EDWARD S. MORSE, we learn from the New York *Nat'n*, has written an interesting paper on the "Traces of an Early Race in Japan," which throws light on a subject hitherto wholly obscure. A race of men called Ainos are believed to have come down from Kamtchatka and to have taken possession of Japan, which they held until displaced in their turn by the Japanese from the south. Of the two races, the Ainos and the Japanese, authentic records exist, but nothing has been known concerning the ancient people whose territory was appropriated